June 3, 1996

EPA-SAB-ACCACA-96-003

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Re: ACCACA Review of Progress on the Retrospective Study of Clean Air Act (CAA) Benefits and Costs from 1970 through 1990

Dear Ms. Browner:

The Advisory Council on Clean Air Compliance Analysis (ACCACA, or the Council; formerly known as the Clean Air Act Compliance Analysis Council, CAACAC) met on June 12 and 13, 1995. This meeting, our first in two years, was devoted to a review of progress on the Congressionally mandated retrospective study of the Clean Air Act (CAA) benefits and costs from 1970 through 1990 (CAA, 1970; 1990). In addition, we reviewed and accepted the June 6, 1995 draft report of the ACCACA Physical Effects Review Subcommittee (PERS), which we transmitted to you as a final report on September 29, 1995 (EPA-SAB-CAACAC-95-022), as well as an advisory dated September 28, 1995 (EPA-SAB-CAACAC-ADV-95-001). The above-cited report and advisory summarizes and highlights our deliberations of the PERS. This report conveys the Council's deliberations and advice on the Agency's progress as of the June 12 and 13, 1995 review. We begin with some general remarks about the study as a whole, address some important issues of style and presentation, present observations about what appeared to be the main quantitatively most important issues, and conclude with discussions of a range of specific issues that came before us.

The Council has reviewed the Agency's draft documents that are being prepared for the Congressionally mandated retrospective study of benefits and costs from 1970 through 1990 under Section 812 of the Clean Air Act (CAA). The Council stressed the importance of providing a sound quantitative picture of total costs and benefits attributable to the CAA. Doing so requires distinguishing clearly between central-case assumptions, which are appropriate for an unbiased analysis of this sort, and worst-case assumptions appropriate for analysis of protective regulation. The Council stressed that the report should also give a sound picture of the qualitative state of knowledge about all readily identifiable effects of the CAA, whether or not they can be valued or even quantified.

With regard to risk and uncertainty, the Council believes that presentation of a single point estimate is at best incomplete as a description of the state of knowledge, and at worst seriously misleading. The Council stressed that the Agency should, where possible, compute and present quantitative measures of uncertainty and that major sources of uncertainty should be described qualitatively as a general matter. Because of controversies within the economics profession regarding Contingent Valuation (CV) methods, the Council believes that the methods used to derive valuation estimates should be presented clearly and visibly.

On other issues of presentation, the Council advised that apparent anomalies in the draft chapters should be corrected. We also advised that predicted employment changes should be deemphasized because their significance is commonly misunderstood, and that predicted changes in Gross National Product (GNP) be deemphasized because GNP also is inferior as a measure of economic welfare to Net National Product (NNP) and Equivalent Variation (EV). The importance of disaggregating costs and benefits where possible was stressed.

It appears that three quantities will be the most important determinants of total estimated benefits: reductions in mortality due to reduced exposure to lead, reductions in mortality due to reduced exposure to particulate matter (PM), and the dollar value attached to lives saved. The Council devoted considerable attention to the last two of these; available information did not permit extensive discussion of lead-related mortality. As regards particulate matter, the Council discussion in June 1995 was clearly not informed by the subsequent CASAC review of Agency documents related to PM (see for instance, U.S. EPA, 1996a, 1996b, and 1996c). We believe that the final treatment of PM-related mortality effects in the retrospective study should be consistent with CASAC's final conclusions.

The Council stressed that the value of a statistical life is not uniform throughout the entire population; it reflects the particular mortality risk-money tradeoff of the population being examined. We argued that the Agency should make an effort to consider the ages at which death is being prevented by the CAA and the expected health status of those who would have died because of air pollution but for the CAA. The Agency must also resolve questions about how it is going to adjust the statistical value of life to reflect issues pertaining to both quality and quantity of life. Four different approaches are offered, and we urge the Agency to explore and compare them.

The Council identified and considered other significant issues, including the treatment of post-1990 benefits, choice of discount rate(s), use of cost-of-illness estimates, valuing reductions in chronic bronchitis, inputs to benefit analysis, relations between peak and average emissions, spatial extrapolation of ozone concentrations, CAA effects on asset replacement decisions, and estimated impacts of lead reduction on wages.

We appreciate the opportunity to review the progress to date on the CAA impact analysis and look forward to receiving your responses to the major points raised in this report. We also look forward to continued productive interaction with the Agency staff in this process on an important topic of interest to many Americans.

Sincerely,

Dr. Richard Schmalensee, Chair
Advisory Council on Clean Air Compliance Analysis

NOTICE

ABSTRACT

The Advisory Council on Clean Air Compliance Analysis (ACCACA or the Council; formerly known as the Clean Air Act Compliance Analysis Council, CAACAC) of the Science Advisory Board (SAB) has reviewed Agency draft documents prepared for the retrospective study of benefits and costs from 1970 through 1990 mandated under Section 812 of the Clean Air Act (CAA). The Council stressed the importance of providing both a sound *quantitative* picture of total costs and benefits attributable to the CAA and a sound *qualitative* picture of the state of knowledge regarding all the CAA's readily identifiable effects, whether or not they can be quantified. The Council stressed that quantitative measures of uncertainty should be presented whenever possible, and major sources of uncertainty should always be described qualitatively.

The Council advised that, because of ongoing controversies, the methods used to estimate valuations should be clearly indicated. Several other issues of presentation were considered, and the Council advised that predicted employment changes should be deemphasized, and costs and benefits should be disaggregated where possible.

The Council devoted considerable attention to estimation of particulate-related mortality changes and to valuation of mortality changes (including variations in the value of a statistical life), as these are likely to be among the most important determinants of estimated total benefits. The Council provided detailed technical advice on both topics, and stressed that the final treatment of particulate-based mortality in the retrospective analysis should be consistent with and should cite the Clean Air Scientific Advisory Committee's (CASAC) ultimate conclusions, taking into account that key issues in this area are studies in which mortality should be based and that the purposes of the retrospective cost-benefit study and the CASAC analysis are different.

Other significant issues were identified and advice was offered on a number of topics, including the treatment of post-1990 benefits, choice of discount rate(s), use of cost of illness estimates, valuing reductions in chronic bronchitis, inputs to benefit analysis (including dollar value attached to lives saved), relations between peak and average emissions, spatial extrapolation of ozone concentrations, CAA effects on asset replacement decisions, and estimated impacts of lead reduction on wages.

<u>Key Words:</u> Air Pollutants, Clean Air Act, Contingent Valuation Methodology, Cost-Benefit Analysis, Economic Valuation, Valuation Methodologies

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Dr. Wayne M. Kachel, Environmental Engineering Committee (EEC); Mele Associates, Brooks Air Force Base, TX

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[1] Although a member of the Council, Dr. Dudek was unavailable to participate in this specific review.

Dr. George T. Wolff, Clean Air Scientific Advisory Committee (CASAC), General Motors Environmental and Energy Staff, Detroit, MI

SAB Staff:

Dr. K. Jack Kooyoomjian, Designated Federal Official, ACCACA, U. S. Science Advisory Board (SAB) (1400F), 401 M Street, S.W., Washington, DC 20460

Mrs. Diana L. Pozun, Staff Secretary, ACCACA, U. S. Science Advisory Board (SAB) (1400F), 401 M Street, S.W., Washington, DC 20460

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1. GENERAL REMARKS

The Council [also known as the Advisory Council on Clean Air Compliance Analysis (ACCACA), and formerly referred to as the Clean Air Act Compliance Analysis Council (CAACAC)] is encouraged that the Agency has made significant progress on this important and complex study in the two years since our previous meeting. We are encouraged that the Agency is undertaking serious and credible analysis (in the face of tight budget constraints) and is attempting to present that analysis in a clear and balanced fashion. We are also pleased that the Agency is apparently eager to finish this study and to move on to the more important prospective study of the benefits and costs of the 1990 Clean Air Act Amendments (CAAA) (CAA, 1990). We were disappointed, however, to learn that the Agency's internal scientific resources, particularly those in the Office of Research and Development (ORD), were still not significantly engaged in the Section 812 study. Given the nature of many of the problems with which this study is concerned, the in-house ORD scientists would bring an essential perspective and could make vital contributions. To this end, we strongly recommend their participation in this exercise.

It is important to note, however, that while speed may now be desirable, haste is not. The retrospective study will almost certainly have a significant impact on environmental policy debates. In order for that impact to be constructive, the study must be honest and credible and able to withstand serious technical criticism. Its results must be presented clearly and in ways that meet the needs of both specialist and non-specialist audiences. To this end, a report structure with short summary chapters backed by detailed technical appendices seems like a sound approach. It is also important to accomplish three distinct but interrelated substantive objectives.

First, the report should present a sound *quantitative* picture of total costs and benefits attributable to the CAA. In order to avoid unnecessary tension between this study and other EPA publications, it is important to distinguish clearly between central-case assumptions, appropriate for an unbiased analysis of this sort, and worst-case assumptions appropriate for protective regulation. (This may be particularly important in the case of air toxics.)

Second, the report should present a sound *qualitative* picture of the state of knowledge regarding all readily identifiable effects of the CAA, whether or not they can be valued or even quantified. Completeness is important here, particularly as regards ecological impacts, which some have argued may have social and political significance disproportionate to dollar amounts that can be justifiably assigned to them. Similarly, due attention can be paid to environmental problems that persisted during the 1970-90 period but were addressed in a sounder fashion in the 1990 CAAA. Distinctions should also be clearly made between effects that are well understood physically but cannot be valued, effects that are not well understood but for which rough magnitudes are known, and effects that are simply uncertain. For credibility, worst case language (e.g., "could be as much as X") should be used sparingly in cases of the latter sort.

Third, if the first two objectives are met, the study will have significant implications for the nation's *environmental research agenda* and for the desirability of alternative monitoring strategies. A third objective is to present and defend those implications clearly.

2. STYLE AND PRESENTATION

2.1 Risk and Uncertainty

Perhaps the most significant shortcoming of the draft report material we were asked to review was its treatment of uncertainty. In areas where there is significant uncertainty, and this is essentially all the areas addressed by the report, presentation of a single point estimate is at best incomplete as a description of the state of knowledge and at worst seriously misleading. Where possible, standard errors or related measures of uncertainty should be computed and presented, with major sources of uncertainty described qualitatively. We recognize that in some phases of the analysis, time and budget constraints effectively rule out any quantitative treatment of uncertainty. It is then even more important to provide a complete qualitative treatment of sources of uncertainty and their rough importance. We note, in addition, the direct logical correspondence between important sources of uncertainty regarding costs and benefits, on the one hand, and desirable research priorities, on the other.

2.2 Contingent Valuation

Members of the Council hold a wide range of opinions on the proper scope for the use of Contingent Valuation (CV) methods and the appropriate criteria to be used in assessing individual CV studies. CV methods are controversial within the economics profession. We do not believe that this Council should attempt to resolve this controversy, but neither do we believe that this study should ignore it. In discussions of valuation, the text should indicate the methods primarily relied upon in each case, and citations should be given to debates regarding the validity of CV and, as necessary, other methods. Serious consideration should be given to visually indicating the methods used to derive estimated values, perhaps by using asterisks and similar characters, in some or all tables. (To put this in perspective, some Council members would strongly prefer that CV not be used at all in this study, while others would object to any suggestion that CV methods are more suspect a priori than others, particularly in the context of valuing health benefits.)

2.3 Ambiguities and Anomalies

The Council review of the draft chapters revealed a number of presentation problems that could cause problems for the study's readers in Congress and elsewhere. The roles of model outputs as against actual data in the control case need to be clarified in the text, and it would be desirable to provide some indications in appendixes of the fit between model outputs and data for this case. In addition, it is important to be clear, probably in an appendix, about the exact role of the Jorgenson-Wilcoxen (J/W) model as an integrating device, especially as regards consistency between aggregate and sectoral predictions from the J/W model and assumptions made elsewhere in the analysis.

The materials we reviewed contained a number of apparent anomalies, such as increases in emissions apparently caused by the CAA and an odd spatial pattern of changes in acid deposition. These sorts of things catch readers' attention and can be used to attack the whole study. They should at least be dealt with in footnotes when they appear. In addition, the choice of units in which results are presented can cause sound results to appear anomalous. As a general rule, results should be presented in units that readers can readily understand or, if it is unclear how to do this, they should be presented in units that relate directly to benefits.

2.4 Costs and Employment

We feel strongly that predicted employment changes from the J/W model should be deemphasized in their presentation. This is not because we necessarily believe that these predictions are flawed. The main problem is that presenting employment changes is likely to encourage readers in the persistent error of trying to think of the costs - and sometimes even the benefits - of environmental programs in terms of job changes. In fact, the Agency would serve at least the cause of clear thinking about its programs if this study contained a paragraph or two noting that the cost of environmental protection is best measured by reductions in national productivity; that environmental programs are unlikely to affect aggregate employment; and that, as a consequence, jobs in "the environmental protection sector" are a cost, not a benefit, because they represent the use of valuable labor worker hours that could be used to produce other goods and services. (The benefits of allocating labor and other resources to environmental protection may, of course, outweigh these costs.)

2.5 Macroeconomic Modeling

In earlier comment, the Council suggested that better measures of economic costs on impacts should be employed. In the latest draft from the Agency, the main measure of economic welfare is Gross National Product (GNP). The Council views this as an unsatisfactory measure for a number of reasons, the chief of which is that any change relative to a baseline includes capital depreciation.

The Council would propose using three alternative measures when the Report to Congress presents a summary of the results on the economic costs, namely: (a) the direct cost of compliance -- a first-order estimate without any feedback; (b) Net National Product (NNP), which is total consumption plus net capital formation -- widely understood by most non-economist readers and quite close to the appropriate measure; and (c) Equivalent Variation (EV), such as was used by Jorgenson, Slesnick and Wilcoxen (1992), employing an intertemporal utility function for infinitely lived "dynasties" with different demographic characteristics -- a slightly better measure than NNP in principle because it includes (estimated) non-market output.

The study is useful in allowing a decomposition of Endogenous Technological Change (ETC) from Factor Substitution (FS). The current baseline simulation includes ETC as the standard scenario. (For clarity, "endogenous technological change" means that the evolution of production functions are affected by factor prices or policy variables.) The Council was concerned that ETC is an unusual specification in the economic growth literature and suggests that EPA present the case with no ETC as a highlighted alternative[2].

The Council's understanding was that the costs without ETC were approximately one-half of the costs with ETC, and this non-standard model could therefore exaggerate the costs. In addition, some CAACAC members were concerned that other technological or productivity effects, such as the impact of the health effects of pollution on productivity, were omitted from the macroeconomic modeling, so the technological benefits of removing the CAA might well be overstated.

Finally, the Council notes that there is some inconsistency in the use of the J/W model in the detailed sectoral analysis. The original philosophy had been to use the J/W sectoral outputs as the drivers of the individual pollution models. EPA should clarify whether this was done and, if not, what inconsistencies arise between the sectoral assumptions and the J/W model.

2.6 Disaggregation of Costs and Benefits

While there is undoubtedly interest in the aggregate benefits and aggregate costs of all CAA programs combined, many readers will want to know about the costs and benefits of specific provisions of the Act, such as those dealing with mobile sources. If only because others will surely attempt to compute such quantities using information from the final report, the final report must itself address disaggregation of this sort - both to show what can be done and to lay out what can't be done. It is clear, for instance, that it is difficult to express even the direct costs of pollution control on a pollutant-by-pollutant basis, for at least two reasons. First, certain controls (e.g., those on mobile sources) reduce several pollutants simultaneously. This raises the difficult problem of apportioning cost among joint products. Second, some pollutants (including sulfur dioxide, nitrogen dioxide, and volatile organic chemicals) are transformed in the atmosphere in part into particulate matter and/or ozone. For example, while it may be possible to determine the fraction of particulate matter that comes from, e.g., sulfur dioxide, this does not help in determining the fraction of the cost of controlling sulfur dioxide that should be ascribed to particulates.

It may be better to work with broad programs (e.g., mobile sources) to which costs can be more easily assigned. This raises the problem of apportioning emissions/exposure reductions across programs. This may be difficult to do even roughly for ozone and perhaps also for particulates. Still, here as elsewhere, rough approximations may be a good deal more useful to all concerned than blank pages.

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[2] Dr. Nordhaus notes that the Council had an earlier comment along these lines, and strongly recommends that both versions be calculated and presented for each of the major experiments.

3. MAIN QUANTITATIVE ISSUES

It appears that three quantities will be the most important determinants of total benefits: reductions in mortality due to reduced exposure to lead, reductions in mortality due to reduced exposure to particulate matter (PM) and possibly ozone, and the dollar value attached to lives saved. While sensitivity analysis is generally desirable, it is particularly desirable that the study contain careful examinations of the consequences of alternative assumptions and methods relating to these three quantities. We were given only a few pages on lead-related mortality and hence cannot deal with related issues in this report. Our views on issues related to the other two quantities follow.

3.1 Particulate-Related Mortality

Since the Council meeting in June 1995, the Clean Air Scientific Advisory Committee (CASAC) has conducted thorough reviews of EPA documents (U.S. EPA,1996a, 1996b and 1996c). We believe that the final treatment of particulate-related mortality in the retrospective analysis should be consistent with (and should cite) CASAC's ultimate conclusions, taking into account that key issues in this area are studies in which mortality should be based and that the purposes of the retrospective cost-benefit study and the CASAC analysis are different.

A minor issue is the approach to be taken to estimating ambient PM concentrations in counties without PM monitors. The Council believes that the importance of PM-related benefits justifies devoting resources to developing extrapolation methods that sensibly use relevant information - and to presenting clearly the residual uncertainty in exposure levels. We note, for instance, that visibility may serve as a good marker for concentrations of fine particulates, that rural and urban counties can be expected to differ systematically, and that information is available regarding the rules for deciding where monitors are placed and on the distribution of concentration across existing monitors.

3.2 Valuing Reductions in Mortality

The value of the mortality benefits of reducing air pollution is clearly central to the EPA analysis. In the draft report, estimates derived from wage-risk tradeoffs are used to derive implicit values of a statistical life. This approach yields a value of life of around $5 million, consistent with the wage/risk evidence.

It should be emphasized, however, that the value of a statistical life is not uniform throughout the entire population. Rather, it reflects the particular mortality risk-money tradeoff of the population being examined. In the case of wage-risk studies, the population group under scrutiny consists primarily of white male blue-collar workers. These individuals may have quite different attitudes toward mortality risk than, for example, people with many more years of life at risk (such as college students) or people whose life expectancy is much lower (such as those with terminal diseases). It should also be noted that the workers in these wage-risk studies self-selected themselves into risky jobs. Individuals exposed to risk involuntarily through the effects of air pollution may be more reluctant to bear mortality risk than workers who have been compensated for the risks they face.

The mortality risk effects may be quite different - both in terms of the nature of the death and the duration of life effects - from those examined in the existing job risk literature. Air pollution related deaths from, for example, respiratory failure may have a different value to the victim than being killed through a traumatic on-the-job injury. If a principal effect of air pollution is to lead to the deaths of those who have terminal cases of lung cancer, for example, then the amount of life expectancy that is added through pollution reduction will be small, and the quality of life that will be affected will be low as well. Alternatively, if air pollution control primarily prevents the deaths of infants and young children who are asthmatics, then the per capita number of years and quality of life at risk would be much larger. Before attempting to attach dollar values to mortality risk effects, it is essential to obtain a quantitative sense of the distribution of mortality effects along dimensions such as these.

Although we understand that the present state of epidemiological knowledge is inadequate to do this in a fully satisfactory manner, the Agency should make an effort to deal with two issues. First, the character of the mortality effects to be valued should be delineated much more precisely. In particular, whose lives are being extended? (Statistical life extension should be the focus of the analysis, since air pollution programs extend lives but do not confer immortality.) At what ages are deaths being prevented? There is some evidence that would enable the Agency at least to establish different risk levels for those 65 years and over and those under 65 years of age. Second, it is desirable to know the expected health status of those who would have died because of air pollution if it had not been for the Clean Air Act. Thus, the overall intent is to obtain some assessment of both the quality and quantity of the lives that are affected.

The Agency must also resolve questions about how it is going to adjust the statistical value of life to reflect issues pertaining to both quality and quantity of life. We offer below four different possibilities and urge EPA to explore several of them to provide a sensitivity analysis with respect to benefit assessment.

First, the Agency could undertake original research to ascertain the benefit values. In particular, using survey methodologies it is possible to assess risk-money tradeoffs among respondent groups who are quite different from those involved in job risk studies. Such a survey may not be feasible for this study, but exploring these issues should be a long-run concern of EPA, since the Agency regularly confronts the benefit assessment problems we discuss here.

Second, there could be an explicit quantity adjustment to reflect the amount of life lost. One possible approach here is to make an adjustment using the discounted expected number of life years for those affected by the air pollution reduction and to scale the mortality risk value by the ratio of the discounted expected life years saved to the discounted expected life years at risk for a typical worker in a wage-risk study. Although various estimates of the implicit rate of discount among workers exist, use of a riskless (real) rate of return in this calculation seems appropriate and is not inconsistent with the confidence intervals for the estimated discount rates in the literature.

A third approach is to value the changes in the value of life based on estimates in the literature on how this value varies with age. The survey results that appear in Jones-Lee et al. (1985) and Jones-Lee (1989) for example, explore how the value of life in England for transportation safety decisions varies with individual age. These relative value figures could be used to rescale value of life numbers. Similar survey evidence might also exist for the United States. In addition, the EPA cites estimates in various studies by Moore and Viscusi (1988, 1990a, 1990b) and Viscusi and Moore (1989) of the implicit discount rate of workers. As part of these studies, the variation in the implicit value of life with age is estimated.

A fourth sensitivity analysis would focus on quality-adjusted life years. Not all the lives at risk may be those of individuals in good health. For some health outcomes, it is possible to establish baseline values that enable one to calculate the change in the value that has been lost. For example, if the initial health status is chronic bronchitis attributable to cigarette smoking, then the EPA benefit assessment for chronic bronchitis provides an index of the welfare that has already been lost because of this disease. Thus, the health value loss associated with deaths of people with chronic bronchitis not due to chronic air pollution exposure could be calculated, at least for illustrative purposes, using both the chronic bronchitis and the mortality estimates in conjunction with one another.

4. OTHER SIGNIFICANT ISSUES

4.1 Post-1990 Benefits

The benefit series in principle includes only gains associated with pre-1990 emissions reductions, although, because of latency periods, those gains include post-1990 deaths averted. The cost series, in contrast, include pre-1990 outlays for capital goods that reduced emissions after 1990 as well as before. The easiest way to avoid this mis-match is to replace the acquisition costs of capital goods with their annual user costs (or rental costs), using judgmental estimates (informed by the Bureau of Economic Analysis (BEA)) of sector-specific average lifetimes and depreciation schedules. We recommend that a day or two be devoted to a back-of-the-envelope exercise here to see if it has a substantial impact on the study's conclusions.

4.2 Discount Rate

Like most groups of economists, the Council members hold a range of opinions regarding the best discount rate to employ in this study. It is important (and easy) to test the sensitivity of the study's conclusions to the use of alternative plausible discount rates. It is also important to be internally consistent in the use of discounting: if the rate used to compute annual user costs of capital goods does not equal the rate used to discount benefits, there should be a sound economic reason for the difference. (It should go without saying that real and nominal magnitudes and real and nominal discount rates should be employed in a consistent fashion. Nominal discount rates should not be used to value real streams, for instance.)

4.3 Cost-of-Illness (COI) Estimates

Although the study attempts to value reductions in morbidity primarily by what individuals would be willing to pay for such reductions, the cost of medical treatment and foregone earnings (the so-called cost-of-illness, COI, approach) is sometimes used for this purpose. Cost-of-illness estimates, when based on reliable data can be a useful adjunct to willingness to pay. (See the discussion of contingent valuation above, however.) In some cases (see Harrington and Portney (1987)), they can be used as a lower bound on willingness to pay.

Care should be taken in presenting COI estimates, however. In particular, a distinction should be made between COI estimates based on large national surveys (such as the National Medical Care Expenditure Survey, see for instance, U.S. NCHSR/NMCES (1981)) and those based on small samples (such as Berger et al. (1987)). In fact, the latter numbers should not be reported. When COI estimates are reported, it should be made clear whether they include foregone earnings as well as medical costs (as would be preferable) or only medical costs.

4.4 Morbidity/Chronic Bronchitis

The dollar values assigned by Industrial Economics, Inc. (See Industrial Economics Incorporated (1993f)) to avoiding a case of chronic bronchitis seem too high. These estimates are based on two articles, Viscusi et al. (1991) and Krupnick and Cropper (1992). Each study values a health outcome -- chronic emphysema -- much more severe and of longer duration than a typical chronic bronchitis episode, so that these numbers will substantially overstate the pertinent benefit value for policy analysis. There is a confusion between a "case" of chronic bronchitis, and an "episode" of chronic bronchitis exacerbation. There is certainly a greater cost in the creation of a "case," following chronic irritant exposure, than in each of the multiple exacerbations of their symptoms following a peak level of daily exposure.

Both studies value willingness-to-pay (WTP) to avoid a statistical case of chronic bronchitis by asking respondents to trade risk of chronic bronchitis for risk of auto death and by asking respondents to trade risk of chronic bronchitis for changes in the cost of living. The former approach yields, for each respondent, the number of auto deaths that are equivalent to a case of chronic bronchitis -- call this N. The dollar value of a case of chronic bronchitis is then obtained by multiplying N by some dollar value of an auto death. The second approach yields a direct estimate of the value of a statistical case of chronic bronchitis.

All of the Viscusi numbers should be regarded as upper bound or overestimates, since the health outcome being avoided is more severe. The value recommended by Industrial Economics(See Industrial Economics Incorporated (1993f)) is based on the first approach, with the value of a statistical life based on unrelated labor market studies used for valuation. At least four alternative approaches are superior. (a) Using the second -- direct -- approach would yield a value of $883,000 based on the mean of the Viscusi et al. (1991) data. (b) Because the distribution of responses in the Viscusi et al. (1991) study is skewed, it may be more appropriate to use the median of the distribution, which is $457,000. Values (a) and (b) are the most defensible estimates, since they are based on the direct preferences expressed within the survey. (c) The description of the case of chronic bronchitis to be valued in the Viscusi et al. (1991) study was of a case more severe than is typical. (It was similar to advanced emphysema.) After adjusting for differences in severity, Rowe et al. (1994) recommended a value per case of chronic bronchitis avoided of $210,000 in 1992 dollars. (d) If one insists on the first -- two stage -- approach, the Viscusi et al. (1991) estimate of the value of an auto death should be used along with the survey's assessment of the auto death equivalent of chronic bronchitis to ensure internal consistency. High skewness of the reported auto death values argues for using the median value, which leads to a value of $800,000 for avoiding a case of chronic bronchitis.

4.5 Benefit Analysis Inputs

We naturally urge the Agency to consider all sound, publicly available studies of pollution effects in its analysis. In particular, the National Acid Precipitation Assessment Project (NAPAP) work on impacts of acid deposition on forests, aquatic ecosystems, and materials and the literature on pollution's effects on agriculture should be taken into account. The Agency's own work on impacts should also be considered, of course, but with the usual caveat that this study should employ measures of central tendency (means or medians), not upper bounds.

4.6 Peak v. Average Emissions

Where standards relate to peak emissions, controls can be expected to hit the right tail of the intertemporal distribution of emissions harder than the mean, thus changing the shape of the distribution. Since the effect on peak emissions is expected to be much larger, using proportional rules to scale up the consequences of aggregate emissions reductions is likely to produce biased estimates. The report should at least note those coefficients that are subject to this bias.[3]

4.7 Extrapolation of Ozone Concentrations

We were asked orally about the estimation of ozone concentrations in areas distant from monitors. (In addition to PM and ozone, similar extrapolation problems apparently arise with regard to SO_2, NO_x, and other pollutants, but we were unable to consider those problems in detail.) We were shown evidence that simple extrapolation procedures based on 20-kilometer and 50-kilometer circles around existing monitors yielded very similar results. We believe that this justifies using an average of the results of the two procedures. We also believe, however, that modest efforts to incorporate information from regional ozone models and data on land use (particularly on the importance of agriculture and forests) may produce better estimates.

4.8 Asset Replacement Decisions

It is our understanding that the study assumes new automobile sales are the same in the control and no-control scenarios. In fact, the work of Gruenspect (1982) and others indicates that pollution control requirements tended to reduce new car sales in the real world as compared to the no-control case and thus increase fleet age and emissions, at least in the short run. Though this effect seems likely to be of little quantitative importance, it should be acknowledged.

More important, the study apparently assumes that controls had no effect on electric utilities' decisions regarding generating unit retirements. It is generally believed, however, that the new-source bias of environmental regulation has tended to delay generating unit retirements substantially (see Maloney and Brady (1988) and Nelson et al. (1993)). Thus, in the no-control scenario, the stock of generating units would tend to be younger than in the control scenario; and, because of the longevity of the equipment involved, this transitional effect would likely persist throughout the study period. This difference would tend to reduce emissions in the no-control

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[3] The Council also notes that Professor J.V. Henderson of Brown University has completed a good deal of empirical research for the National Science Foundation on how average and peak emissions have responded to the CAA. Since we do not believe this work has yet been published, the Agency staff may want to discuss his findings with him directly.

case, all else equal, because new units would generally be considerably more thermally efficient than the old units they would replace. In addition, lower emissions and thus lower damages would generally occur in the no-control case if coal-fired units were replaced by other technologies. This effect of new-source bias may well be quantitatively important, though we doubt that on balance emissions would have been lower in the absence of controls, and we urge the Agency to perform and present a rough assessment of its magnitude.

4.9 Effects of the Lead Documents

It should be noted that the lead documents overstate the impact of lead on wages, because they omit the costs of education and labor-force participation. The correct treatment is to include only the direct effect of lead on Intelligence Quotient (IQ); any induced effects (e.g., the impact on wages from the effect of lead on schooling and the effect of schooling on wages) are to a first approximation zero by the envelope theorem.

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APPENDIX A - GLOSSARY OF TERMS AND ACRONYMS

ACCACA	Advisory Council on Clean Air Compliance Analysis (U.S. EPA/SAB, also known as the Council, or formally as the CAACAC Clean Air Act Compliance Analysis Council (U.S. EPA/SAB)
ADV	Advisory Report
BEA	Bureau of Economic Analysis (U.S. Department of Commerce)
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAACAC	Clean Air Act Compliance Analysis Council (U.S. EPA/SAB)
CAACACPERS	Clean Air Act Compliance Analysis Council, Physical Effects Review Subcommittee (U.S. EPA/SAB)
CASAC	Clean Air Scientific Advisory Committee (U.S. EPA/SAB)
CD	Criteria Document
COI	Cost of Illness
CV	Contingent Valuation
DOI	(U.S.) Department of the Interior
EEC	Environmental Engineering Committee (U.S. EPA/SAB)
EPEC	Environmental Processes and Effects Committee (U.S. EPA/SAB)
ETC	Endogenous Technological Change
EV	Equivalent Variation
FS	Factor Substitution
GDP	Gross Domestic Product
GNP	Gross National Product
GPO	U.S. Government Printing Office
IAQC	Indoor Air Quality Committee (U.S. EPA/SAB)
IQ	Intelligence Quotient
J/W	Jorgenson-Wilcoxen Model
LTR	Letter Report
NAAQS	National Ambient Air Quality Standard
NAPAP	National Acid Precipitation Assessment Project
NC	North Carolina
NCEA	U.S. National Center for Environmental Assessment
NCHSR	National Center for Health Services Research
NMCES	National Medical Care Expenditure Survey
NNP	Net National Product
NOAA	National Oceanic and Atmospheric Administration
OAQPS	Office of Air Quality Planning and Standards (U.S. EPA)
ORD	Office of Research and Development (U.S. EPA)
PERS	Physical Effects Review Subcommittee of the ACCACA, formerly known as the CAACACPERS
PHS	U.S. Public Health Service
PM	Particulate Matter

RTP	Research Triangle Park
SAB	Science Advisory Board (U.S. EPA)
VOCs	Volatile Organic Compounds
WTP	Willingness-to-Pay

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